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A Cross-Sectional Study to Find Out the Incidence and Associated Risk Factors of Pressure Injury Acquired in the ICU Unit at Pt. B.D. PGIMS, Rohtak

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Abstract

Pressure injuries, also known as pressure ulcers or bedsores, remain a major concern in intensive care units (ICUs) due to their adverse impact on patient outcomes and healthcare quality. This study aimed to assess the incidence and associated risk factors of pressure injuries among patients admitted to the ICU at Pt. B.D. Sharma Post Graduate Institute of Medical Sciences (PGIMS), Rohtak. A descriptive cross-sectional design was adopted, and data were collected from 100 ICU patients using a structured clinical assessment tool and the Braden risk assessment scale. Demographic and clinical variables such as age, gender, duration of ICU stay, mobility, nutritional status, moisture exposure, comorbidities, and Braden scores were analyzed. The findings revealed that 27% of patients developed pressure injuries during their ICU stay. A statistically significant association was observed between pressure injury occurrence and factors such as low Braden score (≤16), immobility, and moisture exposure ($p<0.05$). Although variables like nutritional status and comorbidities did not show significant associations, they remain clinically relevant for overall patient management. The study highlights the importance of early identification of at-risk patients and implementation of targeted nursing interventions, including regular repositioning, effective moisture management, nutritional optimization, and use of pressure-relieving devices. These results underscore the need for structured prevention protocols and ongoing staff education to reduce the incidence of pressure injuries in critical care settings and improve patient outcomes.

Keywords: Pressure injuries, Braden Scale, intensive care unit, risk factors, nursing interventions

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INTRODUCTION

Pressure injuries, often referred to as pressure ulcers, decubitus ulcers, or bedsores, are among the most persistent and challenging complications in modern healthcare settings. These injuries are localized damage to the skin and underlying tissues that develop primarily due to prolonged pressure, especially over bony prominences, and may also involve factors such as friction, shear, and moisture. Despite significant advances in medical technology and critical care practices, pressure injuries continue to pose a major threat to patient safety and quality of care, especially within intensive care units (ICUs) where patients are at their most vulnerable.

ICU patients are usually critically ill, frequently immobilized, and may depend on mechanical ventilation or sedation, which limits their ability to change position. This physical immobility, combined with factors like compromised circulation, use of medical devices, and reduced sensory perception, puts them at elevated risk of developing pressure injuries. These injuries are not only painful and debilitating but are also associated with severe complications such as infection, delayed wound healing, prolonged hospital stays, increased medical costs, and even mortality.

The ICU environment, while essential for managing critically ill patients, is paradoxically one of the highest-risk settings for pressure injury development. Patients admitted to the ICUs often have multiple organ dysfunction, are subject to frequent invasive procedures, and require continuous hemodynamic and respiratory support. These conditions necessitate prolonged periods of immobility, and even with specialized mattresses and nursing care protocols, the risk remains significant. The use of vasopressors, sedatives, and paralytics further exacerbates tissue hypoxia and perfusion deficits, thus increasing susceptibility to skin breakdown.

Globally, the incidence and prevalence of pressure injuries in ICU settings vary. Studies have shown that ICU-acquired pressure injuries affect 10–40% of patients, depending on the healthcare system, available resources, and quality of nursing care. Developed countries with robust healthcare systems and adequate nurse-to-patient ratios may report lower incidence rates due to better implementation of prevention strategies. However, in developing nations such as India, the incidence tends to be higher due to factors such as inadequate staffing, limited training, poor infrastructure, and a lack of standardized guidelines for pressure injury prevention.

In India, comprehensive nationwide data on pressure injury prevalence in ICUs are scarce. However, institutional studies conducted in tertiary hospitals indicate that pressure injuries are a significant concern. For instance, several hospital-based studies have reported prevalence rates between 4% and 18%, with ICU patients being more prone due to their critical health conditions. These studies also indicate that many pressure injuries go unnoticed until they progress to more severe stages, leading to further complications and the need for surgical interventions such as debridement or skin grafting.

Pt. B.D. Sharma Post Graduate Institute of Medical Sciences (PGIMS), Rohtak, is a premier tertiary-level teaching hospital that caters to a vast patient population across North India. The ICUs at PGIMS—including the medical, surgical, and trauma units—handle a large influx of critically ill patients requiring multidisciplinary care. Despite advancements in critical care and the use of high-end medical technologies, PGIMS has not conducted a comprehensive internal study on ICU-acquired pressure injuries, their incidence, or associated risk factors. This gap in institutional knowledge makes it difficult to assess the quality of current preventive strategies or identify areas needing improvement.

The issue of pressure injury extends beyond clinical complications. From a public health perspective, these injuries contribute to increased hospital stay duration, strain on healthcare staff, psychological distress for patients, and significant financial costs. The emotional toll on patients and their families, coupled with the legal and ethical responsibilities of healthcare providers, adds to the urgency of addressing this issue effectively. In many international healthcare systems, pressure injuries are now classified as “never events,” implying they are largely preventable with appropriate care.

Multiple intrinsic and extrinsic factors contribute to the development of pressure injuries. Intrinsic factors include patient age, comorbidities such as diabetes and cardiovascular diseases, nutritional status, and immune function. Older patients and those with chronic illnesses are at increased risk due to thinner skin, reduced tissue perfusion, and slower healing capabilities. Malnutrition, often marked by low albumin and protein levels, impairs the body’s ability to repair damaged tissues, making it a key predictor of pressure injury development.

Extrinsic factors pertain to external conditions and interventions during the hospital stay. These include the duration and intensity of pressure over specific body parts, friction and shear forces during repositioning or bed transfers, moisture due to incontinence or sweating, and improper use of medical devices such as oxygen masks, endotracheal tubes, and urinary catheters. Poor positioning and infrequent repositioning further exacerbate the situation. Additionally, inadequate staffing, lack of training in pressure injury prevention, and the absence of standardized risk assessment tools, such as the Braden Scale, contribute to the problem.

The prevention of pressure injuries requires a multidisciplinary approach involving physicians, nurses, dietitians, and physiotherapists. Timely risk assessment using validated tools, regular repositioning schedules, appropriate use of pressure-relieving surfaces (e.g., air mattresses, cushions), maintenance of skin hygiene, nutritional support, and staff education are key components of effective prevention. Nursing staff, being at the forefront of patient care, play a vital role in early detection and the implementation of these measures.

Monitoring pressure injuries is also an important quality-control measure in hospital settings. The incidence rates of pressure injuries are used to assess the quality of nursing care and overall hospital performance. Institutions that succeed in minimizing these injuries demonstrate a high standard of patient-centered care, whereas those with higher rates may face scrutiny from accreditation bodies and regulatory authorities.

The current study seeks to bridge the knowledge gap regarding pressure injuries at PGIMS, Rohtak. By evaluating the incidence of ICU-acquired pressure injuries and analyzing associated risk factors, the study will provide data-driven insights into the current challenges faced in critical care settings. This information is crucial for designing effective intervention strategies that can reduce the incidence of pressure injuries and improve patient safety and outcomes.

Moreover, this study has the potential to set precedents for future quality improvement initiatives and institutional policymaking. Evidence gathered from this research could lead to revisions in ICU protocols, improved training modules for healthcare staff, better allocation of resources, and the adoption of standardized risk assessment tools. The findings will also contribute to the academic literature and aid researchers and practitioners in understanding the dynamics of pressure injury development in resource-constrained settings.

Need for the Study

Pressure injuries, also referred to as pressure ulcers or bedsores, have emerged as one of the most persistent healthcare-associated conditions, particularly in critical care settings such as ICUs. Globally, they are recognized as major indicators of the quality of nursing care, clinical outcomes, and hospital safety practices. Despite being largely preventable through comprehensive nursing protocols and evidence-based interventions, pressure injuries continue to occur at alarming rates, particularly among critically ill patients. The ICU environment, by virtue of its complexity, patient immobility, and technological intensity, becomes an arena where such injuries are not only frequent but also highly detrimental to patient recovery.

Pt. B.D. Sharma PGIMS, Rohtak, being one of the largest tertiary referral centers in Haryana, serves as a hub for critically ill patients from across the region. The ICU units of PGIMS manage complex medical and surgical cases, often involving prolonged mechanical ventilation, invasive monitoring, hemodynamic instability, and pharmacologic sedation—all of which are known risk factors for pressure injuries. Despite the prevalence of such conditions, there is a lack of institution-specific empirical data documenting the incidence and associated risk factors of pressure injuries in the ICU setting. This gap hinders the ability of healthcare professionals and administrators to design effective strategies tailored to the institution's patient population and resource capabilities.

The current literature underscores the importance of surveillance, prevention, and early intervention in reducing the burden of pressure injuries. However, most studies are either based on Western populations or are limited in scope when it comes to Indian healthcare settings. Cultural factors, resource availability, nurse training, patient demographics, and differences in healthcare policies across countries render foreign data partially or wholly inapplicable. Therefore, it is imperative to generate locally relevant data through studies such as the present one, which can not only inform institutional protocols but also contribute to national health policy frameworks.

Furthermore, hospital accreditation bodies such as the National Accreditation Board for Hospitals & Healthcare Providers (NABH) and international organizations like the Joint Commission International (JCI), which emphasize the reduction of hospital-acquired conditions, have identified pressure injuries as a major quality improvement focus. Hospitals failing to report or manage pressure injuries effectively may face accreditation challenges, financial penalties, and reputational damage. This adds institutional urgency to comprehensively address the issue through data-driven strategies.

A significant aspect of the need for this study lies in the current transitional phase of Indian healthcare, which is moving toward more patient-centric, safety-oriented care delivery. Nurses are increasingly empowered as frontline defenders against complications such as pressure injuries. Identifying training gaps, workflow efficiencies, and resource adequacies within the ICU at PGIMS will therefore provide actionable insights for capacity building and quality improvement. Nurse-led interventions, supported by data from this study, can lead to improved patient outcomes, reduced incidence of pressure injuries, and more efficient utilization of ICU resources.

Additionally, the psychological and emotional impacts of pressure injuries on patients and their families cannot be ignored. Patients experiencing these injuries may suffer from reduced self-esteem, anxiety, depression, and social isolation. Family members, too, undergo stress as they witness the pain and suffering of their loved ones. In a culturally sensitive environment such as India, where familial bonds are strong, such complications can cause distress far beyond the individual patient. A comprehensive understanding of the factors leading to pressure injuries can therefore contribute to more compassionate and holistic patient care.

Technological advancements in healthcare—such as electronic medical records, advanced diagnostic imaging, and automated risk assessment tools—offer promising avenues for pressure injury prevention and management. However, their successful integration into daily clinical practice depends on institutional readiness, financial investment, and staff training. This study will identify gaps that may hinder such integration at PGIMS and recommend feasible, context-specific strategies to address them.

The absence of institution-specific data, especially in a resource-sensitive healthcare environment such as India, means that many pressure injury prevention protocols are inconsistently applied or borrowed from Western models that may not be fully suitable. By offering insights rooted in local practices and constraints, this study will help in designing culturally and operationally relevant protocols that are both practical and sustainable.

The need for this study is not only justified but imperative. It addresses an urgent clinical issue, fills a critical knowledge gap, supports institutional quality improvement, and contributes to national healthcare goals. It also has the potential to improve patient care, reduce hospital stays, minimize healthcare costs, and enhance the overall experiences of patients and their families. The findings of this study will be instrumental in guiding future policies, improving training programs, and fostering a culture of safety and compassion in critical care environments such as the ICU at PGIMS, Rohtak.

Objectives

1. To determine the incidence of pressure injuries acquired in the ICU.

2. To identify the factors associated with pressure injuries acquired in the ICU.
3. To examine the association between the incidence of pressure injuries and their associated factors in the ICU.
4. To assess the association between the incidence of pressure injuries acquired in the ICU and selected clinical variables.

Operational Definition

- *Incidence:* Refers to the number of new cases of pressure injury that develop during a specific period of time.
- *Associated factors:* Refers to variables that are linked with an increased risk of developing pressure injuries in the ICU.
- *Pressure injury:* Refers to localized damage to the skin and underlying soft tissue, usually occurring over a bony prominence or caused by a medical or other device.
- *ICU:* Refers to an organized unit designed to provide intensive and specialized medical and nursing care to critically ill patients.

Hypothesis

H1: There will be a significant association between the incidence of pressure injuries and the associated factors in the ICU.

H2: There will be a significant association between the incidence of pressure injuries acquired in the ICU and selected demographic and clinical variables.

DELIMTATIONS

The Study is Limited to ICU Patients Only

The research focuses exclusively on patients admitted to the ICU at Pt. B.D. PGIMS, Rohtak. Patients from other departments or general wards were excluded.

Cross-Sectional Design is Used

This study captures data at a single point in time rather than following patients longitudinally, meaning trends over time or long-term outcomes of pressure injuries are not considered.

Only Selected Risk Factors are Considered

This study investigated commonly observed risk factors such as age, duration of immobility, nutritional status, comorbidities, and medical device usage. Other potential contributing factors were not evaluated.

Conceptual Framework

A conceptual framework serves as the blueprint for a research study, providing a structured perspective on the variables and relationships under investigation. In this study, a cross-sectional design was used to determine the incidence and associated risk factors of pressure injuries acquired in the ICU at Pt. B.D. Sharma PGIMS, Rohtak. The conceptual framework helps in identifying, categorizing, and understanding the multiple dimensions that influence the occurrence of pressure injuries in ICU patients. This model is instrumental in guiding data collection, analysis, and interpretation of results (Figure 1).

REVIEW OF LITERATURE

The literature review provides a foundation for understanding the existing body of knowledge related to pressure injuries, particularly in the ICU setting. It identifies the risk factors, interventions, and outcomes associated with pressure injuries, offering critical insights into what has been studied and what gaps remain.

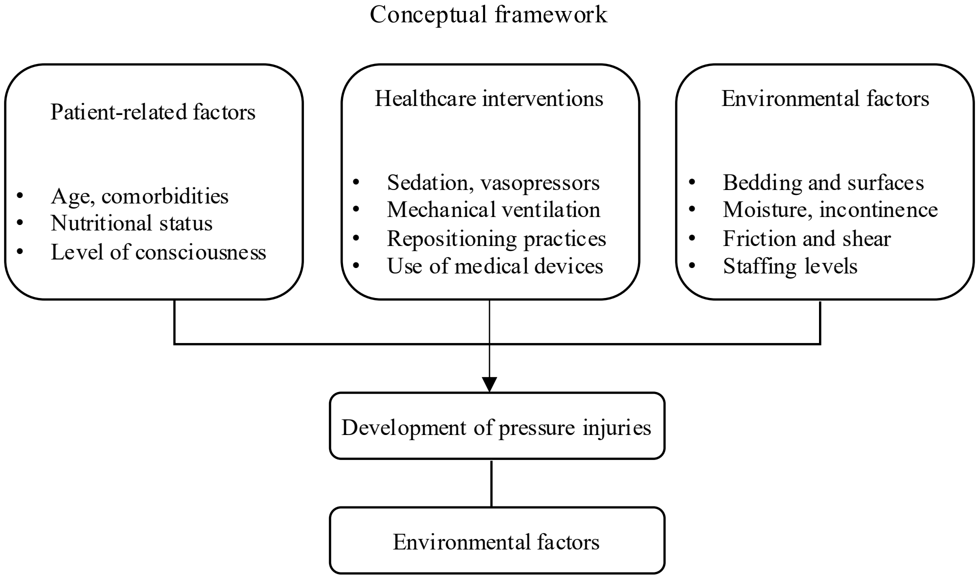

Figure 1. Conceptual framework depicting the risk factors and outcomes associated with pressure injuries in ICU patients.

Murthy et al. (2019) [1] conducted a cross-sectional, population-based study to assess the prevalence of blindness and visual impairment among adults aged 40 years and above in Nigeria. The Nigerian National Blindness and Visual Impairment Survey included over 13,500 participants selected through multistage stratified cluster random sampling. Using standard World Health Organization (WHO) definitions and examination protocols, the study revealed that 4.2% of the population were blind (presenting visual acuity <3/60 in the better eye), 6.1% had severe visual impairment, and 15.2% had moderate visual impairment. Cataract was the leading cause of blindness (43.0%), followed by glaucoma (16.7%) and uncorrected refractive errors (7.5%). Notably, 84% of the causes of blindness were avoidable. Rural areas showed a higher prevalence than urban areas. The study emphasized the need for integrated and accessible eye care services and policies to prevent avoidable blindness through early intervention, particularly in rural and underserved communities.

Coyer et al. (2017) [2] conducted an institution-based descriptive study in northern India to evaluate the causes of visual impairment among patients attending a tertiary care hospital. A total of 2,100 patients aged 18 years and above were included, with detailed ocular examinations, history taking, visual acuity testing, refraction, and slit-lamp biomicroscopy. The results revealed that 52% of the patients presented with refractive errors, 21% with cataracts, 9% with glaucoma, and 6% with diabetic retinopathy. Younger participants (<40 years) predominantly had uncorrected refractive errors, whereas older individuals showed a higher incidence of cataracts and glaucoma. This study highlights the importance of early screening and affordable access to corrective devices and cataract surgeries. The findings support strengthening primary eye care services and expanding community outreach to identify and manage vision issues at an early stage, especially in resource-limited settings.

Flaxman et al. (2017) [3] conducted a global systematic review and meta-analysis to estimate the global and regional burden of blindness and visual impairment. This large-scale study included data from over 180 countries and incorporated more than 350 studies into a comprehensive model. In 2015, 36 million people were blind globally, and 217 million had moderate-to-severe visual impairment. Uncorrected refractive errors and cataracts were the primary causes. The burden of vision loss is disproportionately high in low-income countries, particularly in sub-Saharan Africa and South Asia. Aging populations and limited access to surgical services and optical care have contributed to this growing burden. The researchers projected that, without interventions, the global prevalence could increase significantly by 2050. They advocated for global investment in low-cost interventions and technology to reduce preventable blindness.

Dulal S. (2012) [4] conducted a cross-sectional study among older adults in Nepal to estimate the prevalence and causes of visual impairment. A total of 5,800 individuals aged 50 years and above were examined through door-to-door vision screening and subsequent referral to eye care centers for detailed evaluation. The findings showed a prevalence of blindness (2.3%), severe visual impairment (5.7%), and moderate visual impairment (12.6%). Cataracts were the most common cause of blindness (67.8%), followed by corneal opacities and glaucoma. The majority of causes were found to be avoidable. The study emphasized the necessity of national eye health strategies, including mobile eye camps, cataract outreach programs, and improved health-seeking behaviors among older populations. These results underscore the importance of improving eye health literacy and accessibility in rural and mountainous regions.

Resnikoff et al. (2004) [5] conducted a WHO review to compile global data on visual impairment. Their assessment highlighted that approximately 161 million people worldwide were visually impaired, with 37 million being blind. Approximately 90% of these cases occurred in developing countries. Cataracts remained the principal cause, accounting for nearly 48% of blindness cases. The study pointed out that 75% of all visual impairments were preventable or curable. The report also stressed the importance of the Vision 2020 initiative, which aims to eliminate avoidable blindness through disease control, human resource development, and infrastructure support. The authors advocated for government and NGO partnerships to scale up services in underserved regions. Health education, increased funding, and integration of eye health into general health systems were suggested as critical enablers for achieving the program’s goals.

Murthy G.V. et al. (2010) [6] carried out a comparative study in Tamil Nadu, India, to assess the prevalence and causes of visual impairment before and after the implementation of community-based eye care interventions. Surveys were conducted in 2002 and 2007 among adults aged 50 years and above. The results showed a reduction in the prevalence of blindness from 7.5% to 3.2% over 5 years. This decline was largely attributed to increased cataract surgeries, improved community participation, and the introduction of vision centers in rural areas. The study documented a positive correlation between community mobilization and increased uptake of services. The findings also indicated improvement in cataract surgical outcomes, with more procedures performed using intraocular lens implantation. The study concluded that sustainable and community-owned approaches are essential for achieving long-term eye health improvements.

Bourne R. et al. (2013) [7] conducted a systematic review and analysis through the Global Burden of Disease Vision Loss Expert Group to update global trends in visual impairment from 1990 to 2010. Data from population-based surveys were analyzed using statistical models to estimate regional and global burdens. The report revealed a 19% decrease in the age-standardized prevalence of blindness and a 25% reduction in moderate and severe visual impairment over a 20-year period. These improvements were attributed to expanded cataract surgical services and better refractive-error correction globally. However, the absolute number of people affected continued to rise due to aging populations. The study emphasized the growing need for long-term planning and increased investment in ophthalmic human resources and infrastructure to meet the rising demand.

Wen L. et al. (2020) [8] conducted a study on the prevalence of visual impairment in patients with diabetes mellitus across six Asian countries, including China, India, and Malaysia. This cross-sectional study involved 12,400 diabetic patients aged 40–80 years. The findings revealed that 31.2% of the participants had some form of visual impairment, with diabetic retinopathy and macular edema being significant contributors. The study noted that poor glycemic control, long-standing diabetes, and lack of regular eye examinations were key risk factors. Despite awareness of diabetes-related complications, uptake of annual eye screening remained low. The researchers recommended integrating eye screening into routine diabetes care and increasing public awareness. Teleophthalmology and retinal imaging in primary care settings were suggested as potential solutions for early detection and referral in low-resource environments.

Pascolini D. et al. (2012) [9] conducted an analytical review using WHO data from 2010 to report global estimates of visual impairment. The study included figures for both low vision and blindness based on visual acuity. It was estimated that 285 million people were visually impaired, of whom 39 million were blind. Notably, 80% of all visual impairments were considered avoidable. Cataracts were the leading cause (51%), followed by uncorrected refractive errors (42%) and glaucoma (8%). This burden was especially high among older adults and women. The researchers emphasized the need to prioritize women's eye health and increase global efforts in training ophthalmic professionals. National eye care programs should be strengthened with improved data collection systems, enhanced surgical coverage, and better optical services to meet the needs of aging populations worldwide.

Chan V.F. et al. (2020) [10] conducted a community-based study in KwaZulu-Natal, South Africa, to measure the prevalence and causes of visual impairment among schoolchildren aged 5–18 years. More than 3,500 students were screened using Snellen's chart and referred for ophthalmological assessment. Uncorrected refractive errors were the most common cause of visual impairment, accounting for 63% of cases. The study found significant differences in access to eye care based on socioeconomic status and school type. Children in rural government schools had higher rates of undiagnosed visual problems than those in urban or private schools. The authors highlighted the need for school-based vision screening programs and partnerships with NGOs to provide free or low-cost corrective lenses. They concluded that addressing visual impairment in children can have a lasting impact on educational outcomes and overall well-being.

Muhit M. et al. (2016) [11] conducted a large-scale household survey in rural Bangladesh to determine the burden of blindness and visual impairment among adults. The Rapid Assessment of Avoidable Blindness (RAAB) methodology was used to examine 4,200 individuals aged ≥ 50 years. The prevalence of blindness was 2.2%, and visual impairment (both moderate and severe) was 10.4%. Cataracts accounted for 77% of blindness cases. The study found that women had a higher risk of visual impairment, attributed to gender disparities in access to surgery and healthcare services. Barriers to surgery included cost, lack of awareness, and cultural perceptions. The findings call for gender-sensitive approaches in eye care, increased community outreach, and integration of primary healthcare workers into vision screening activities.

Gou Q. et al. (2023) [12] conducted a retrospective study to identify risk factors associated with medical device-related pressure injuries (MDRPIs) in ICU patients. The study analyzed data from 500 ICU patients over a one-year period. The findings revealed that advanced age (OR=1.06), diabetes mellitus (OR=3.20), edema (OR=3.62), lower Braden Scale scores (OR=1.22), higher Sequential Organ Failure Assessment (SOFA) scores (OR=4.21), prolonged use of medical devices (OR=1.11), vasoconstrictor use (OR=6.07), surgical procedures (OR=4.36), prone positioning (OR=24.71), and prone-position ventilation (OR=17.51) were significant risk factors for MDRPIs. The study emphasized the need for targeted preventive strategies to address these risk factors and reduce MDRPI incidence in ICU settings.

Fleurence R.L. (2005) [13] conducted a quality improvement study evaluating the cost-effectiveness of using viscoelastic foam mattresses and self-adjusting air bladders in preventing pressure ulcers among high-risk patients. The intervention led to a significant reduction in the incidence of pressure ulcers and resulted in cost savings of $714,724. The study concluded that investing in advanced pressure-relieving mattresses is both clinically beneficial and economically advantageous for healthcare facilities.

Engkasan et al. (2023) [14]—A systematic review assessed the effectiveness and cost implications of alternating-pressure (active) air beds, overlays, and mattresses compared to standard foam mattresses in preventing pressure ulcers. The analysis indicated a small cost-saving benefit and a reduction in pressure ulcer incidence with the use of active pressure-relieving devices. The study recommends the adoption of these devices in clinical settings to enhance patient outcomes and reduce healthcare costs.

Karimian M. et al. (2020) [15]—A pilot study investigated the impact of an educational intervention on nurses' knowledge regarding pressure ulcer risk assessment and prevention. The intervention consisted of workshops and training sessions. Post-intervention assessments showed a significant improvement in nurses' knowledge and application of pressure ulcer prevention strategies. This study highlighted the importance of continuous education in enhancing nursing practices related to pressure ulcer prevention.

Guerrero J.G. et al. (2023) [16]—A multicenter assessment evaluated nurses' knowledge of pressure ulcer prevention using the Pressure Ulcer Knowledge Assessment Tool (PUKAT). The study found unsatisfactory scores, particularly in areas related to effective positioning, repositioning techniques, and the use of preventive devices. The findings underscore the need for targeted educational programs to address these knowledge gaps and improve patient care quality.

RESEARCH METHODOLOGY

Research methodology is a way to systematically solve the research problem. It may be understood as the science of studying how research is conducted scientifically. It involves studying the various steps generally undertaken by a researcher in examining a research problem, along with the logic behind them.

Research Approach

The research approach forms the foundation of any scientific inquiry, guiding the overall strategy and direction of the study. For the present investigation—"A Cross-Sectional Study to Determine the Incidence and Associated Risk Factors of Pressure Injury Acquired in the ICU Unit at Pt. PGIMS, B.D. Sharma, Rohtak"—a quantitative research approach has been adopted. This approach is appropriate because the study aims to collect numerical data, statistically analyze the incidence rate, and identify associations between pressure injuries and possible risk factors among ICU patients.

Research Design

The present study followed a cross-sectional descriptive research design to assess the incidence of and associated risk factors for pressure injuries among ICU patients at Pt. B.D. Sharma PGIMS, Rohtak. This design allows data collection at a single point in time, offering a clear picture of the current prevalence and contributing factors without any intervention. It is non-experimental and observational, ideal for identifying associations between variables such as ICU stay duration, comorbidities, and mobility status. This approach supports the study's goal of generating evidence-based insights to guide prevention and management strategies for pressure injuries in critical care settings (Figure 2).

Research Setting

The study will be conducted in the ICU of Pt. B.D. Sharma PGIMS, Rohtak, a premier tertiary care teaching hospital in Haryana. The ICU is a specialized unit equipped with advanced monitoring and life-support systems that caters to critically ill patients across various medical and surgical departments. The setting is ideal for the study, as it provides a controlled environment with diverse patient conditions, ensuring the availability of relevant clinical data.

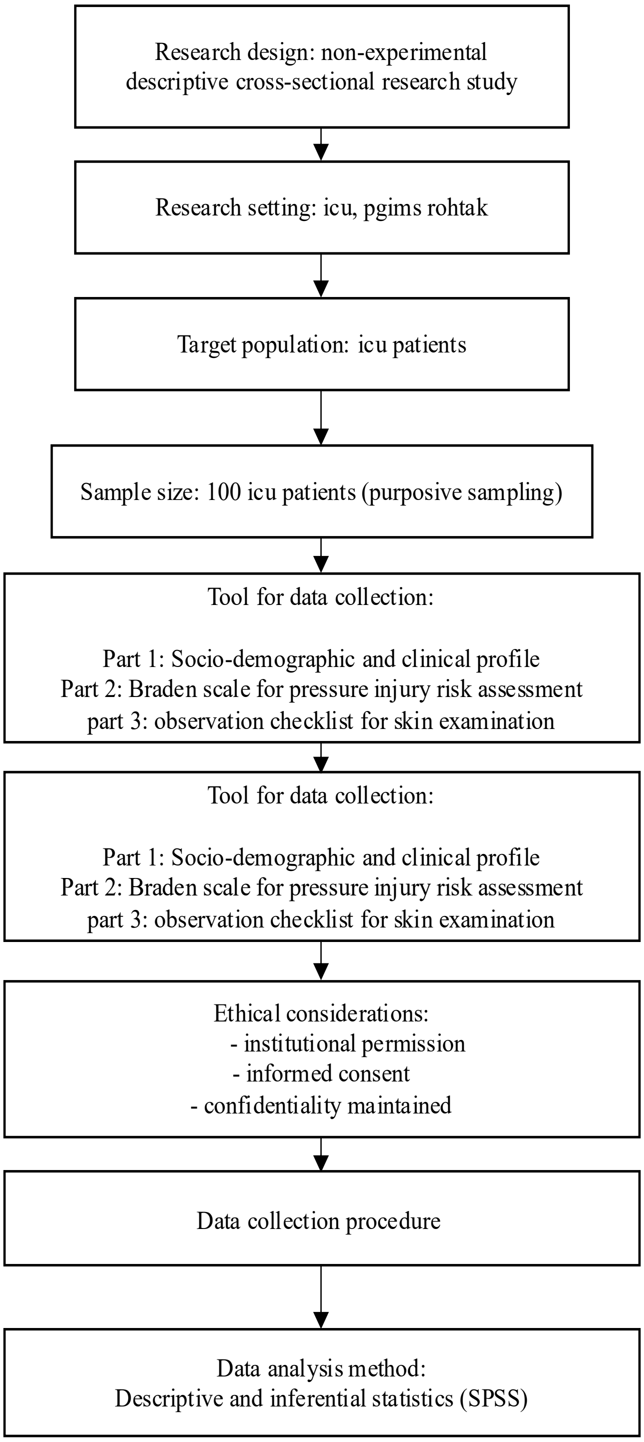

Figure 2. Schematic representation of research design.

Population

The population for the present study includes adult patients admitted to the ICU of Pt. B.D. Sharma PGIMS, Rohtak. ICU patients are often critically ill, immobile, and exposed to several risk factors that predispose them to pressure injuries. These factors include prolonged bed rest, compromised nutritional status, use of medical devices, and multiple comorbidities. Therefore, this population provides an appropriate sample for assessing the incidence and exploring the associated risk factors of pressure injuries in a highly dependent clinical setting.

Target Population

The target population consists of all adult patients admitted to the ICU during the defined study period, regardless of diagnosis. The accessible population includes those patients who meet the predefined inclusion criteria, are available during the data collection period, and whose clinical data can be ethically accessed. This population allows researchers to generate findings that are contextually relevant to critical care practices within a tertiary hospital setup.

Sample Size

The sample size for this study has been determined based on the feasibility of data collection within the defined time frame and the average admission rate in the ICU at Pt. B.D. Sharma PGIMS, Rohtak. Considering the cross-sectional nature of the study and the availability of eligible participants, 100 adult ICU patients will be included using appropriate inclusion and exclusion criteria.

Sampling Technique

For "A Cross-Sectional Study to Find Out the Incidence and Associated Risk Factors of Pressure Injury Acquired in ICU Unit at Pt. B.D. PGIMS, Rohtak," a non-probability purposive sampling technique has been adopted. This approach is suitable for clinical settings in which specific characteristics are present in participants to yield meaningful and relevant data.

Sampling Criteria

The sampling criteria include a set of rules that determine which participants will be included or excluded from the study. These are divided into inclusion and exclusion criteria, which help reduce confounding variables and improve the accuracy and consistency of the data collected.

Inclusion Criteria

- *Adult patients aged 18 years and above:* Adult physiology and risk factors differ from pediatric populations; this criterion ensures uniformity in clinical evaluation.
- *Patients admitted to the ICU of Pt. B.D. PGIMS, Rohtak during the study period:* These individuals represent the defined study population and reflect the setting where pressure injuries are a clinical concern.
- *Patients who are likely to stay in the ICU for more than 24 hours:* Pressure injuries typically develop over time; therefore, patients with shorter ICU stays may not provide relevant data.

Exclusion Criteria

- *Patients under the age of 18 years:* Pediatric patients have different risk profiles and are not included in this study.
- *Patients expected to stay in the ICU for less than 24 hours:* These patients are less likely to develop pressure injuries or provide sufficient data for analysis.
- *Patients in terminal stages or on palliative care:* Preventive care for pressure injuries may not be a clinical priority for such patients, which could affect the results.

This carefully designed sampling strategy ensures that only relevant and reliable participants are included in the study. It enhances the quality of the findings by reducing bias and focusing on ICU patients who are most likely to provide meaningful data on the incidence and risk factors associated with pressure injuries.

Variables Under the Study

In any scientific study, identifying and classifying variables plays a fundamental role in designing the research framework and guiding the analysis. This cross-sectional study aimed to determine the incidence of and associated risk factors for pressure injuries among ICU patients at Pt. B.D. PGIMS, Rohtak. Several independent, dependent, and extraneous variables have been identified.

Dependent Variables

The dependent variable is the primary outcome of interest, which is expected to change or respond to influencing factors. In this study, the dependent variable was:

- *Occurrence of pressure injuries:* This variable denotes whether the patient developed a pressure injury during the ICU stay. The presence, stage, and anatomical location of the injury are documented.

Independent Variables

These are risk factors or predictors that influence the development of pressure injuries. They were measured to examine their association with pressure injury occurrence. Key independent variables include:

- Demographic Factors:
  - Age
  - Gender
- Clinical Characteristics:
  - Duration of ICU stay
  - Level of mobility
  - Nutritional status
  - Presence of comorbidities (e.g., diabetes, hypertension, cardiovascular diseases)
  - Use of medical devices (e.g., ventilators, catheters)
  - Level of consciousness (e.g., GCS score)
  - Skin condition at the time of admission
  - Medication use (e.g., corticosteroids, sedatives)

These variables are hypothesized to directly or indirectly influence skin integrity in ICU patients and their risk of developing pressure injuries.

Extraneous Variables

Extraneous variables are factors not of primary interest but which could influence the results if not controlled. Examples include:

- Quality of nursing care and frequency of patient repositioning
- Staff-to-patient ratio
- Environmental factors such as mattress type and ICU equipment used
- Hygiene practices and infection control protocols

Although these factors were not directly studied, their potential effects will be noted during data collection for discussion in the analysis phase.

Proper identification and management of these variables ensure a comprehensive evaluation of pressure injury incidence and a robust understanding of risk factors in ICU settings. These insights support the development of evidence-based preventive strategies tailored to high-risk patients.

Data Collection

Data for this study were collected from both primary and secondary sources. Primary data were obtained directly through structured observation and interaction with patients, caregivers, and healthcare professionals where appropriate. Secondary data were extracted from patients' clinical records, treatment charts, and nursing care documentation.

The main focus of data collection was to monitor patients from the point of their ICU admission until discharge, transfer to another unit, or the development of a pressure injury. Following a patient-centered model, data were collected continuously during their ICU stay to record any changes in skin integrity and overall health status.

Data Collection Procedure

Step 1: Identification of Eligible Participants

Using predefined inclusion and exclusion criteria, ICU patients were screened based on their medical records, clinical status, and admission history. Only those who met the inclusion criteria were considered eligible to participate in the study.

Step 2: Informed Consent

Written informed consent was obtained from conscious patients after explaining the purpose and process of the study. For unconscious or critically ill patients, consent was obtained from their legal guardians or caregivers.

Step 4: Baseline Data Collection

Demographic and clinical data such as age, sex, (BMI), diagnosis, comorbidities, level of consciousness, and Braden Scale score were recorded upon enrolment using the structured checklist and patient records.

Step 5: Daily Observations and Monitoring

The researcher conducted daily bedside observations to monitor the patient's skin integrity, posture, repositioning intervals, nutritional intake, use of pressure-relieving devices, and any signs of pressure injury. This continued until discharge, transfer, or the development of a pressure injury.

Step 6: Use of Data Collection Tools

The structured observational checklist and Braden Scale were used consistently for all patients. Skin condition assessments and risk factor evaluations were noted and scored accordingly.

Step 7: Data Entry and Verification

The collected data were entered into a master sheet or software tool for further statistical analysis. The entries were double-checked for accuracy, consistency, and completeness.

Step 8: Safe Storage of Records

All patient-related data, consent forms, and observation sheets were stored securely in a locked file and/or password-protected digital folder, accessible only to the research team.

Step 9: End of Monitoring and Final Assessment

At the end of the patient's ICU stay (discharge, transfer, or death), a final evaluation was conducted to determine whether a pressure injury had developed. The findings were documented and included in the overall analysis.

Data Collection Techniques

Multiple techniques are utilized to collect data accurately, minimize bias, and maximize representativeness:

- *Structured observation:* This technique is used to directly observe patient posture, mobility, repositioning intervals, skin condition (redness, ulcers, discoloration), use of pressure-relieving devices, and hygiene maintenance practices.
- *Record review:* Clinical records, including progress notes, nursing charts, skin assessment forms, medication logs, and nutrition sheets, are reviewed systematically to gather data on predisposing medical conditions, length of ICU stay, laboratory results, and pharmacotherapy that might contribute to skin breakdown.
- *Interaction with nursing staff or family members:* Brief, informal interviews may be conducted to gather supplementary information about the patient's condition, such as baseline mobility prior to ICU admission, family-reported concerns, and observed changes in skin condition.

Data Collection Tool

The structured tool used in this study to collect data from ICU patients consisted of the following parts:

Part 1: Socio-Demographic and Clinical Profile of ICU Patients

This part consisted of 10 items covering the basic demographic and clinical variables of ICU patients, such as:

- Age
- Gender
- Educational status
- Occupation
- Monthly family income
- Type of residence (urban/rural)
- Duration of hospital stay
- Comorbid conditions (e.g., diabetes, hypertension, obesity)
- Nutritional status (via BMI)
- Mobility status and level of consciousness

These details were collected through patient records and direct communication with the caregiver or staff nurse (where applicable).

Part 2: Risk Assessment Tool—Braden Scale for Predicting Pressure Sore Risk

The Braden Scale is a validated clinical assessment tool widely used to predict the risk of developing pressure injuries in patients, especially in critical care settings.

The Braden Scale evaluates six sub-categories:

1. *Sensory perception*—Ability to respond meaningfully to pressure-related discomfort
2. *Moisture*—Degree to which the skin is exposed to moisture
3. *Activity*—Degree of physical activity
4. *Mobility*—Ability to change and control body position
5. *Nutrition*—Usual food intake pattern
6. *Friction and shear*—Degree of assistance needed to move and the degree of sliding on the bed or chair

Scoring Interpretation

The Braden Scale assesses a patient's risk of developing pressure injuries by evaluating six key areas. Each category is scored on a scale from 1 to 4, with the exception of friction and shear, which are scored from 1 to 3. The total score ranges from 6 to 23.

A lower score indicates a higher risk of developing pressure injuries, as it reflects greater impairment in the assessed domains.

The Braden Scale is widely used to assess a patient's risk for developing pressure injuries by evaluating sensory perception, moisture, activity, mobility, nutrition, and friction/shear. Based on the total score, patients are classified into different risk categories ranging from "no risk" to "very high risk" (Table 1). Lower Braden scores indicate a greater likelihood of skin breakdown and the need for more intensive preventive interventions.

Part 3: Observational Checklist to Assess the Development and Characteristics of Pressure Injuries

This checklist was developed to assess the presence and severity of pressure injuries among ICU patients. It includes the following components:

- Location of pressure injury (sacrum, heels, elbows, etc.)
- Stage of pressure injury (I to IV as per NPUAP guidelines)
- Size and depth of the wound
- Presence of slough or necrosis
- Exudate amount and odor
- Condition of the surrounding skin
- Signs of infection or inflammation

Table 1. Braden Scale risk categories and corresponding clinical interpretations for pressure injury development.

Total score range	Risk category	Explanation
19–23	No risk	The patient is functioning well in all areas (mobility, nutrition, skin condition, etc.) and is at very low risk for pressure injuries.
15–18	Mild risk	The patient may have some minor issues, such as reduced activity or mild incontinence, requiring preventive care like regular repositioning.
13–14	Moderate risk	The patient has moderate deficits, such as poor nutrition or decreased sensory perception. Pressure injury prevention strategies must be applied.
10–12	High risk	The patient is likely immobile, has frequent moisture exposure (e.g., incontinence), and has poor nutritional intake. Active prevention is critical.
≤9	Very high risk	The patient is severely compromised in most or all areas. Intensive interventions (special beds, turning schedules, nutritional support) are required.

Part 4: Documentation and Monitoring Format

This section served as a daily record sheet for tracking:

- Patient repositioning frequency
- Use of pressure-relieving devices (e.g., air mattress, cushions)
- Nutritional support (oral, enteral, or parenteral)
- Incontinence management
- Skin hygiene practices by staff

Part 5: Scoring Interpretation and Summary Reporting

- Patients were categorized based on their risk level (from the Braden score) and the actual development of pressure injuries.
- Outcomes were documented as:
    - No pressure injury
    - Developed pressure injury (specify stage)
- The frequency and progression of pressure injuries were analyzed in correlation with patient risk factors.

Validity of the Tool

Validity refers to the extent to which a research tool accurately measures what it is intended to measure. In this study, content validity was established to ensure that the tool comprehensively covered all relevant domains related to the risk of pressure injuries in ICU patients. Content validity specifically assesses whether the instrument reflects the full breadth and depth of the construct it aims to measure—in this case, risk factors for pressure injuries.

The structured tool used in the study included three parts:

1. Socio-demographic variables of ICU patients (e.g., age, sex, medical history)
2. Braden pressure ulcer risk assessment scale
3. Checklist of contributing clinical factors for pressure injury development

To confirm content validity, the complete tool was submitted to a panel of eight experts from the fields of nursing and clinical medicine, including professors, clinical practitioners, and subject specialists. Each expert was asked to evaluate the tool for relevance, clarity, simplicity, and comprehensiveness. Feedback and suggestions received from the experts were reviewed critically, and appropriate modifications and refinements were made based on their recommendations.

The final tool, after expert validation, was considered valid and appropriate for assessing the incidence and contributing factors of pressure injuries in ICU settings.

Ethical Considerations

- Prior permission was obtained from the Institutional Ethical Committee of Pt. B.D. Sharma University of Health Sciences, Rohtak, to ensure the study adhered to ethical standards.
- Written consent was obtained from the Medical Superintendent and the ICU in-charge of the selected hospital for conducting the study in the ICU setting.
- Informed written consent was obtained from each participant or their legal guardian (in cases where the patient was unconscious or unable to provide consent).
- The purpose and procedure of the study were clearly explained to all participants or their family members before data collection.
- Anonymity and confidentiality of participants were strictly maintained throughout the study. No personal identifiers were disclosed at any stage of data handling or reporting.
- Participants were assured that participation was voluntary and that they had the right to withdraw from the study at any time without penalty or impact on their medical care.
- All collected data were treated with strict confidentiality and used solely for this research.
- Ethical principles such as beneficence, non-maleficence, autonomy, and justice were upheld throughout the entire research process.

Pilot Study

A pilot study was conducted prior to the main research on 15 ICU patients to assess the feasibility, appropriateness, and reliability of the research tools designed to evaluate the risk factors and clinical aspects of pressure injuries among ICU patients. The pilot study was carried out from December 20, 2024, to January 5, 2025, in the ICUs of Pt. B.D. Sharma PGIMS, Rohtak.

Participants were selected using the purposive sampling technique, and all 15 patients met the established inclusion criteria. Before beginning data collection, the investigator introduced herself, clearly explained the purpose and process of the study, and obtained informed written consent from the patients or their legal guardians (in cases of unconsciousness or medical limitation).

The tools utilized in the pilot study included a socio-demographic data sheet, the Braden Scale for pressure ulcer risk assessment, and a structured clinical checklist focusing on contributing risk factors such as immobility, nutritional status, comorbidities, and skin assessment.

The reliability of the tools was tested using the test-retest method and calculated via Cronbach's alpha, yielding a coefficient of $R=0.78$, which confirmed that the tool was statistically reliable for use in the main research. All patients or guardians cooperated well during the pilot study, and the tool was found to be clear, practical, and effective in collecting necessary data within the ICU setting.

Procedure for Data Collection

Data collection is the systematic process of gathering information necessary to address the research problem. The investigator conducted the main study from March 15, 2025, to April 15, 2025, at Pt. B.D. Sharma PGIMS, Rohtak, in the ICU setting.

A total of 100 ICU patients were selected based on predefined inclusion criteria using the purposive sampling technique. The investigator introduced herself to the ICU staff and patients (or their legal guardians in the case of unconscious or non-communicative patients) and established a good rapport. The purpose of the study was explained clearly, and the confidentiality of all data was assured. Written informed consent was obtained from all participants or guardians before initiating data collection.

The data collection was performed in two phases:

Phase 1: Structured Questionnaire and Risk Factor Checklist

A structured tool was used to gather information on socio-demographic variables such as age, gender, duration of ICU stay, comorbid conditions (e.g., diabetes, sepsis), nutritional status, level of consciousness, and mobility status. A risk assessment checklist based on known clinical risk factors for pressure injuries was used. This included evaluation of skin integrity, moisture exposure, sensory perception, friction, and shearing forces.

Phase 2: Braden Scale Assessment and Visual Skin Examination

The Braden Scale for pressure ulcer risk assessment was used to determine each patient's level of risk. Each patient was evaluated based on the following criteria:

- Sensory perception
- Moisture
- Activity
- Mobility
- Nutrition
- Friction and shear

Each category was scored individually and added to calculate a total score, which helped classify patients into mild, moderate, or high-risk groups for pressure injury development.

Detailed procedure followed:

- Ensured a calm ICU environment for undisturbed assessment
- Obtained necessary permission from the ICU in-charge for bedside data collection
- Explained the purpose of the study to the patients or caregivers
- Maintained strict aseptic protocols and hand hygiene before and after interacting with each patient
- Observed and palpated bony prominences (sacrum, heels, elbows, scapula) for early signs of pressure injuries
- Used sterile gloves for each assessment
- Recorded findings of the Braden score and skin inspection in patient documentation sheets
- Marked any skin changes, redness, or ulceration as per the National Pressure Injury Advisory Panel (NPIAP) staging system
- Ensured patient privacy and dignity during skin examination
- Discussed any critical findings with the on-duty ICU nursing staff for immediate care initiation

Data Analysis Method

The collected data were analyzed using both descriptive and inferential statistical methods, with the help of Microsoft Excel and SPSS software. The analysis was based on the objectives of the study and the research hypotheses.

Descriptive Statistics

Descriptive statistics were used to analyze the socio-demographic and clinical characteristics of ICU patients, including age, sex, duration of stay, comorbidities, nutritional status, and Braden Scale scores. The data were tabulated and presented using:

- Frequency
- Percentage
- Mean
- Standard deviation

These statistical measures were applied to describe the incidence and stages of pressure injuries and the distribution of risk factors among ICU patients.

Inferential Statistics

Inferential statistics were used to draw conclusions and assess relationships between variables. The following tests were applied:

- Chi-square test to assess the association between pressure injuries and selected demographic variables such as age, mobility, nutritional status, and comorbid conditions
- Mean score and standard deviation were computed to evaluate the overall Braden Scale risk categorization
- An independent t-test/ANOVA (where applicable) was planned to compare mean risk scores between different groups (e.g., male vs. female, diabetic vs. non-diabetic)
- A p-value of <0.05 was considered statistically significant

This analytical approach helped in identifying statistically relevant risk factors associated with the development of pressure injuries among ICU patients.

ANALYSIS AND INTERPRETATION

This article presents the statistical analysis and interpretation of data collected from ICU patients at Pt. B.D. PGIMS, Rohtak. The study aimed to determine the incidence of pressure injuries and identify the associated risk factors among critically ill patients admitted to the ICUs.

The data were organized, tabulated, analyzed, and interpreted using descriptive and inferential statistics, according to the structured objectives of the study.

Organization of Data

Data are presented under the following headings:

- Section A: Distribution of demographic and clinical variables of ICU patients
- Section B: Incidence of pressure injuries in the ICU
- Section C: Identification of associated risk factors for pressure injury
- Section D: Association between pressure injuries and selected variables

Section A: Distribution of Demographic and Clinical Variables

Table 2 presents the frequency and percentage distribution of demographic and clinical characteristics of ICU patients (N=200). The data show that the majority of patients (36%) were between 51 and 70 years of age, followed by 28% in the 31–50 years group. More than half of the patients were male (59%), while females constituted 41%. Regarding the length of ICU stay, over half of the patients (51%) remained in the ICU for more than seven days.

In terms of mobility status, most patients (73%) were bedridden, and only 7% were independently mobile. With respect to nutritional status, nearly half of the patients (45%) had a normal BMI, whereas 19% were underweight, 25% were overweight, and 11% were obese. Among the comorbidities, diabetes mellitus (29%) and hypertension (22%) were the most common, while 32% of patients had no comorbidities. Concerning the use of pressure-relieving devices, less than half (46%) of the patients used such devices, whereas 54% did not (Table 2).

Figure 3 depicts the percentage distribution of participants according to age. The analysis of participant age revealed that the highest proportion, 36%, belonged to the 51–70 years age group. This was followed by 28% of participants in the 31–50 years group and 24% in the above-70 years category. A smaller segment, comprising 12%, was under the age of 30 years.

Table 2. The frequency and percentage distribution of demographic and clinical characteristics of the ICU patients (N=200).

Variable	Category	Frequency (F)	Percentage (%)
Age (years)	<30	12	12%
	31–50	28	28%
	51–70	36	36%
	>70	24	24%
Gender	Male	59	59%
	Female	41	41%
Length of ICU stay	<3 Days	15	15%
	4–7 Days	34	34%
	>7 Days	51	51%
Mobility Status	Bedridden	73	73%
	Limited Mobility	20	20%
	Independent	7	7%
Nutritional status (BMI)	Underweight	19	19%
	Normal	45	45%
	Overweight	25	25%
	Obese	11	11%
Comorbidities	Diabetes Mellitus	29	29%
	Hypertension	22	22%
	Sepsis	17	17%
	No Comorbidity	32	32%
Use of pressure-relieving devices	Yes	46	46%
	No	54	54%

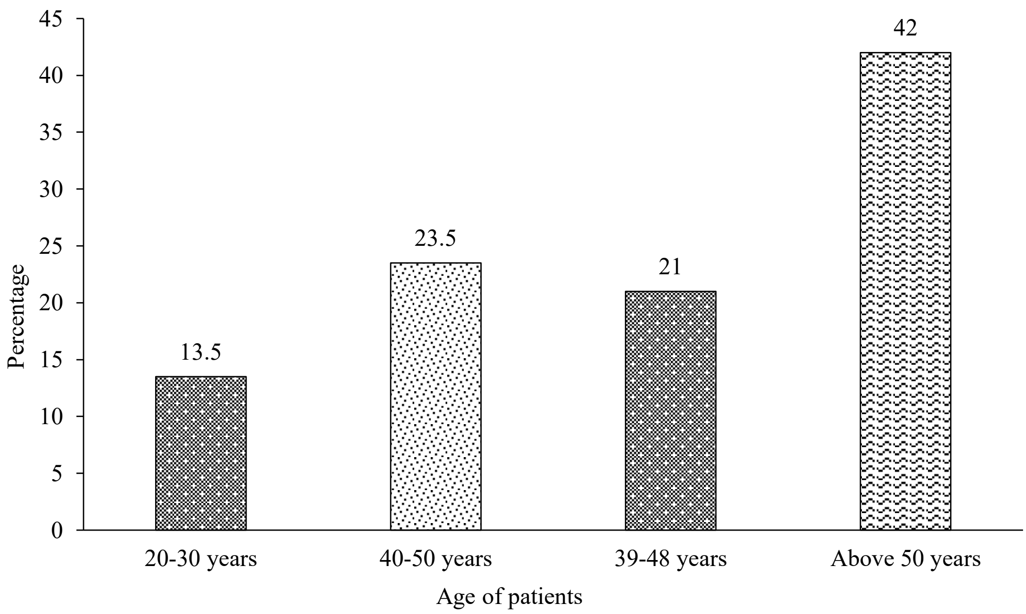

Figure 3. Percentage distribution of participants according to their age.

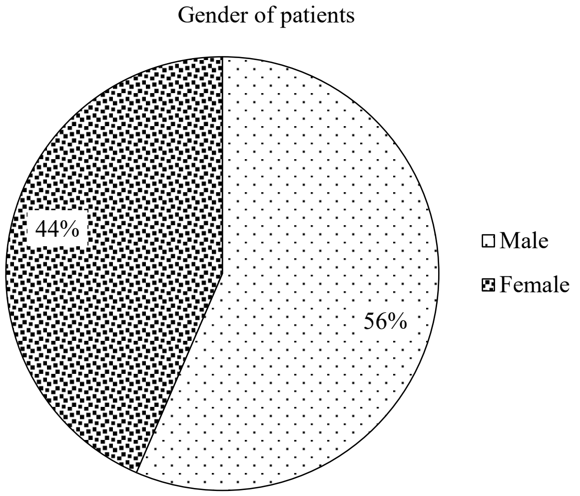

Figure 4. Percentage distribution of participants according to their gender.

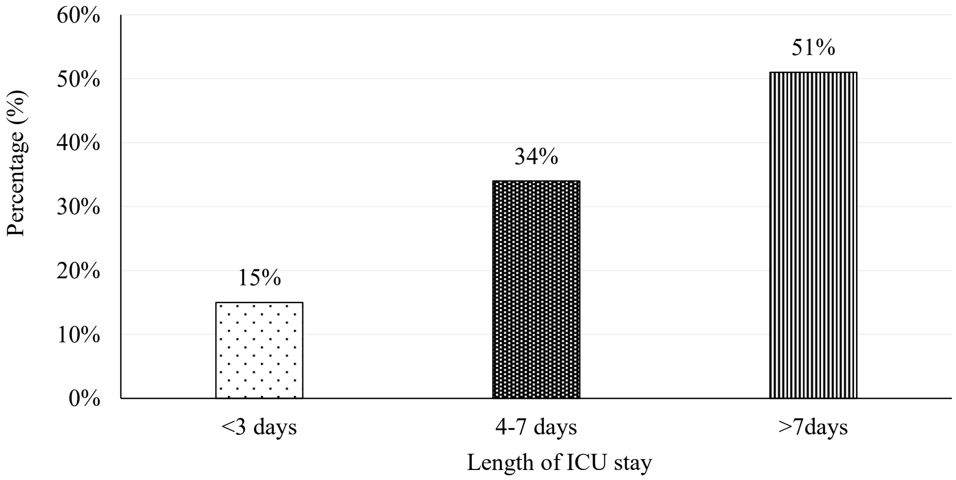

Figure 5. Percentage distribution of participants according to length of ICU stay.

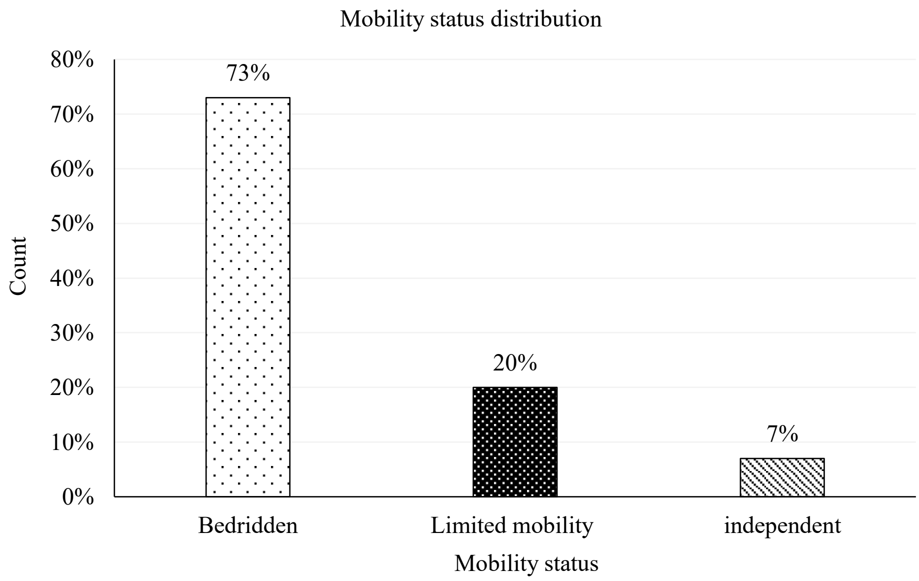

Figure 6. Percentage distribution of participants according to mobility status.

Figure 4 depicts the distribution of adults based on gender: 59% were male, and 41% were female.

Figure 5 shows the percentage distribution of participants according to the length of ICU stay. The analysis revealed that the majority (51%) had an ICU stay of more than 7 days, followed by 34% who stayed for 4–7 days, and only 15% had a stay of less than 3 days.

As shown in Figure 6, the distribution of mobility status indicates a high degree of dependency within the population. The data revealed that a substantial majority (73%) of patients were classified as bedridden. The limited mobility group accounted for 20% of the total, while only a small minority (7%) were fully independent. This distribution highlights the critical need for support services and interventions that focus on highly dependent populations.

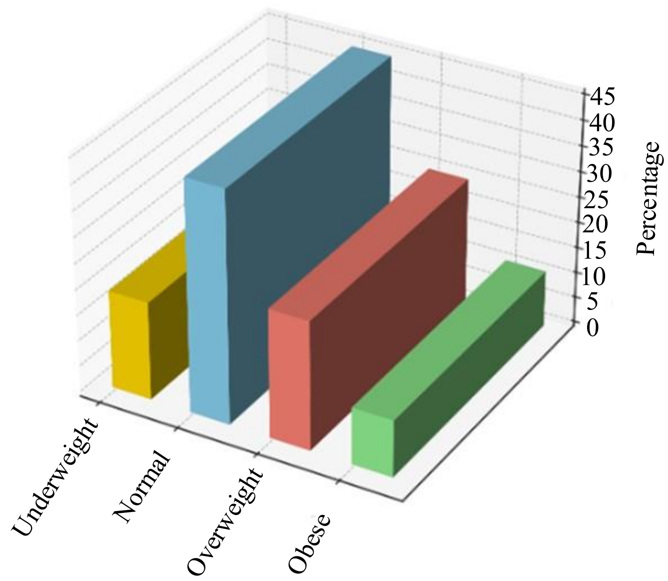

Figure 7. Percentage distribution of participants according to nutritional status (BMI).

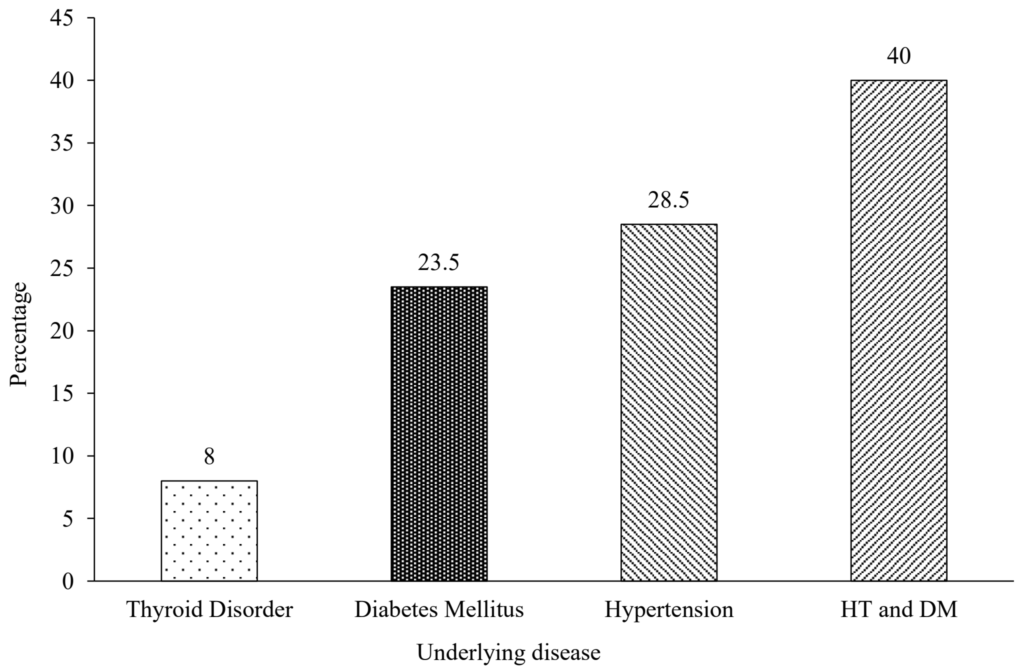

Figure 8. Percentage distribution of participants according to their underlying disease.

Figure 7 illustrates the percentage distribution of study participants based on their nutritional status, as assessed by body mass index (BMI). The majority of patients fell within the normal BMI range, while a smaller proportion were categorized as underweight or overweight. This distribution suggests that although most ICU patients maintained adequate nutritional status, a considerable subset demonstrated suboptimal nutrition, which may influence skin integrity and wound healing capacity. Since poor nutrition is a recognized contributing factor to delayed tissue repair and increased vulnerability to pressure injuries, these findings highlight the importance of routine nutritional assessment and timely dietary interventions in critically ill patients (Figure 7).

Figure 8 shows the comorbidities of adults: 29% had diabetes mellitus, 22% had hypertension, 17% had sepsis, and 32% had no comorbidity.

Figure 9 shows the use of pressure-relieving devices: 54% of participants were in the "No" category, while 46% were in the "Yes" category.

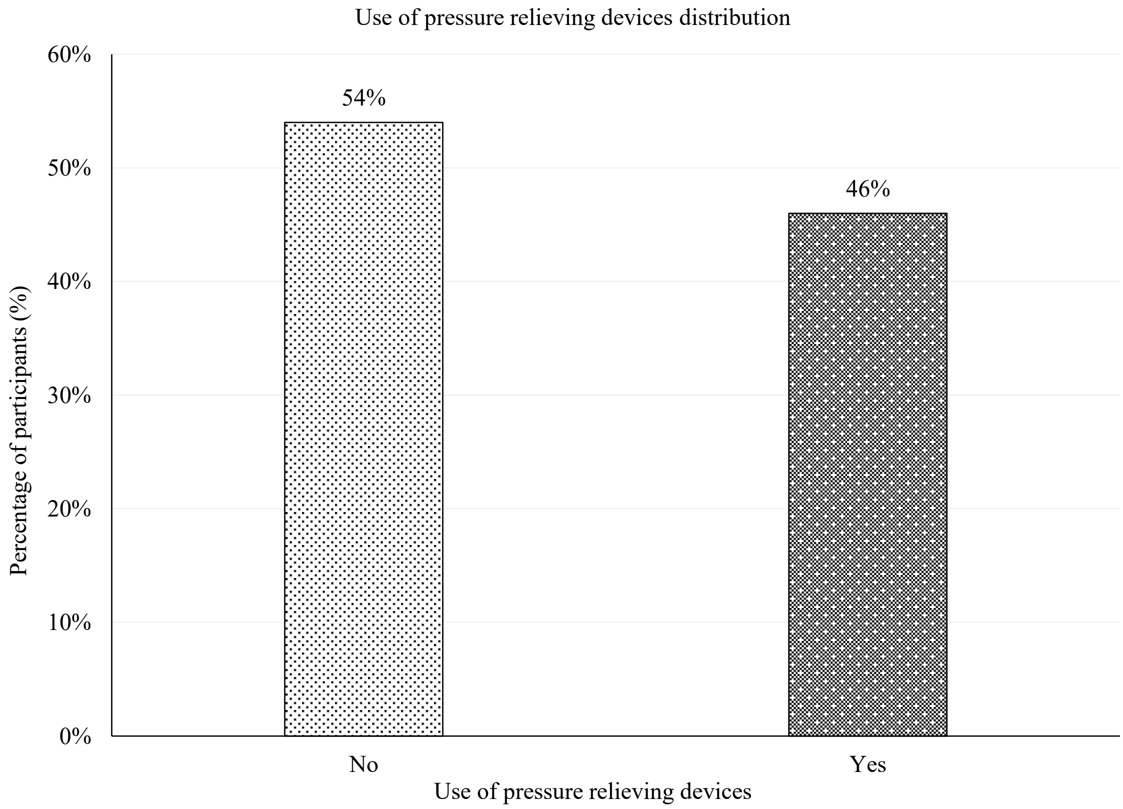

Figure 9. Percentage distribution of participants according to use of pressure-relieving devices.

Table 3. Distribution of ICU patients based on risk level (Braden Scale scores).

Risk category	Score range	Frequency (F)	Percentage (%)
High risk	≤12	21	21%
Moderate risk	13–14	28	28%
Mild risk	15–16	34	34%
No risk	≥17	17	17%

Section B: Assessment of Risk and Development of Pressure Injuries Among ICU Patients

Table 3 presents the distribution of ICU patients based on their risk levels as determined by the Braden Scale scores. The data indicate that the majority of patients (34%) were categorized as having a mild risk (scores 15–16), followed by 28% who were at moderate risk (scores 13–14). A smaller proportion, 21%, were identified as being at high risk (scores ≤12), while 17% of patients had no risk (scores ≥17). This distribution suggests that a considerable number of ICU patients fall within the mild to moderate risk categories, emphasizing the importance of continuous monitoring and preventive care measures to reduce the incidence of pressure injuries (Table 3).

Figure 10 shows the Braden Scale risk assessment: 34% of the participants were at mild risk, 28% were at moderate risk, 21% were at high risk, and 18% were at no risk.

Table 4 presents the incidence of pressure injuries among ICU patients. The data reveal that a majority of patients (68%) did not develop any pressure injury during their ICU stay. Among those who did, 14% experienced Stage 1 injuries, 10% had Stage 2 injuries, 5% developed Stage 3 injuries, and a small proportion (3%) had Stage 4 injuries. This distribution indicates that while most patients remained free from pressure injuries, a notable minority experienced varying degrees of skin damage, underscoring the need for regular skin assessment and effective preventive interventions in the ICU setting (Table 4).

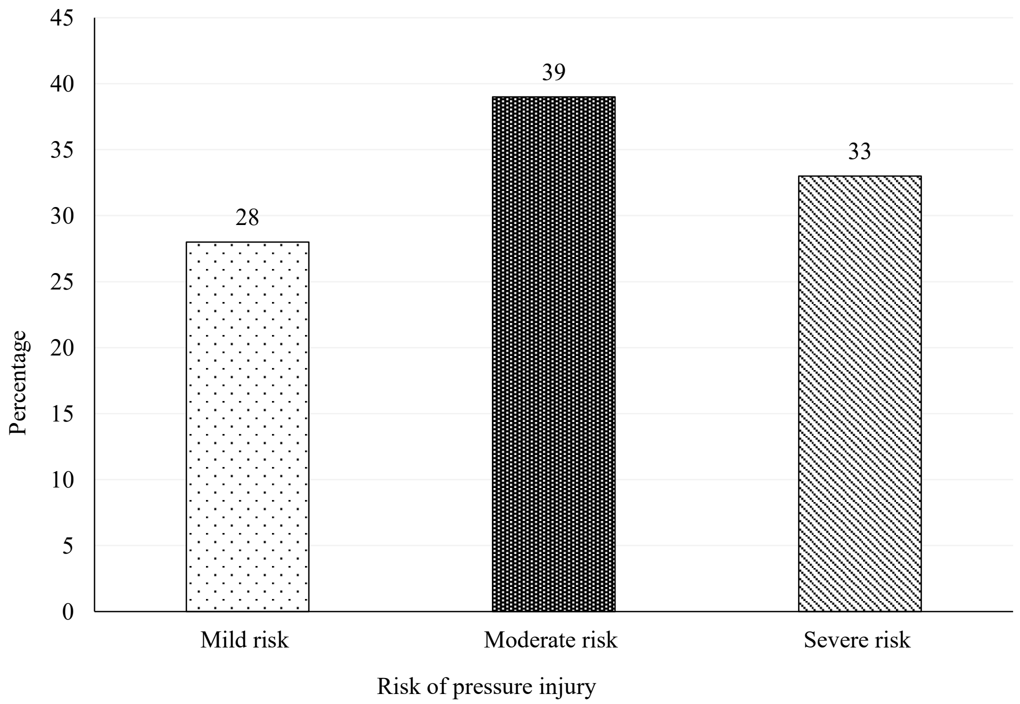

Figure 10. Percentage distribution based on the Braden Scale risk assessment.

Table 4. Incidence of pressure injuries among ICU patients.

Pressure injury stage	Frequency (F)	Percentage (%)
No pressure injury	68	68%
Stage 1	14	14%
Stage 2	10	10%
Stage 3	5	5%
Stage 4	3	3%

Figure 11 shows the stages of pressure injuries: 68% of the participants had no pressure injury, 14% had Stage 1, 10% had Stage 2, 5% had Stage 3, and 3% had Stage 4.

Chi-Square Test Result: $\chi^2=24.76$, $p<0.01$ (Statistically Significant)

Table 5 presents the association between the risk category (as measured by the Braden Scale) and the development of pressure injuries among ICU patients. The results show that out of 21 patients classified as high risk, 17 developed pressure injuries, whereas 4 did not. In the moderate-risk group, 10 patients developed injuries while 18 did not. Among those with mild risk, only 5 developed injuries compared to 29 who remained injury-free. Notably, none of the patients in the no-risk category developed a pressure injury.

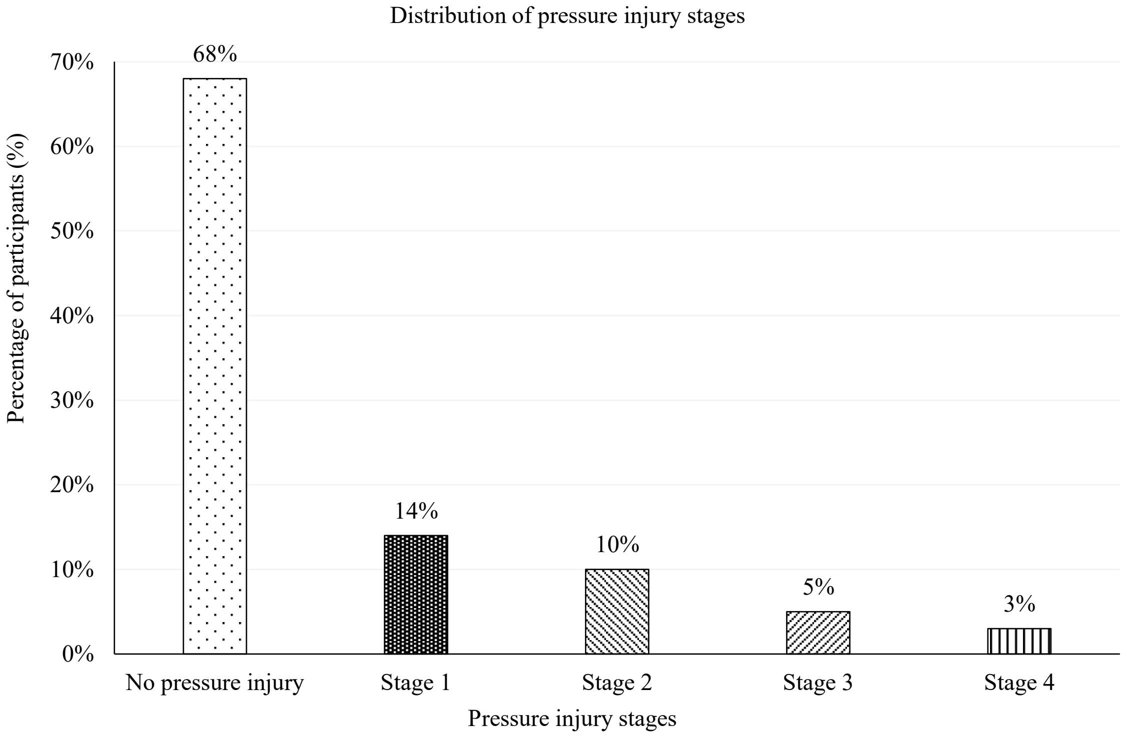

Figure 11. Percentage distribution of participants according to pressure injury stage.

Table 5. Association between risk category and development of pressure injuries.

Risk category	Developed injury	No injury	Total
High risk	17	4	21
Moderate risk	10	18	28
Mild risk	5	29	34
No risk	0	17	17

The chi-square test revealed a statistically significant association between the risk category and the development of pressure injuries ($\chi^2=24.76$, $p<0.01$), indicating that patients with higher Braden risk scores were more likely to develop pressure injuries (Table 5 and Figure 12).

Section C: Assessing the Causes of Pressure Injuries Among ICU Patients

Pressure injuries, also known as pressure ulcers or bedsores, remain a significant health concern in ICUs globally. These localized injuries to the skin and underlying tissues are primarily caused by prolonged pressure—particularly over bony prominences—or a combination of pressure and shear. ICU patients, often immobile and critically ill, are at heightened risk due to various physiological, clinical, and systemic factors. This section explores and analyzes the multifactorial causes of pressure injuries among ICU patients, integrating evidence from the literature with clinical observations to provide a comprehensive understanding.

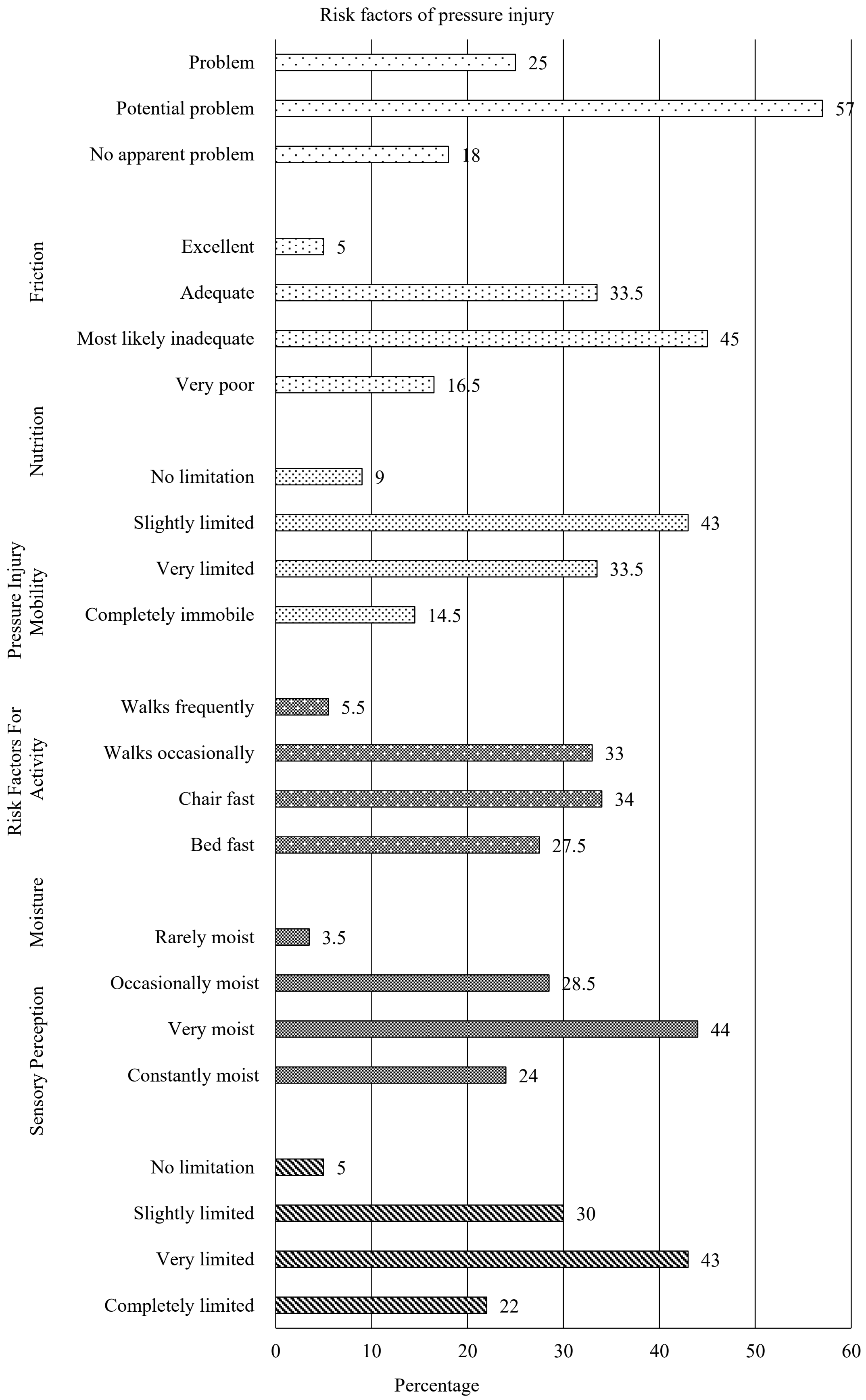

Figure 12. Association between risk category and development of pressure injuries.

Hemodynamic Instability and Poor Perfusion
Immobility and Decreased Mobility

One of the most prominent causes of pressure injuries in ICU patients is prolonged immobility. Critically ill individuals are often sedated, mechanically ventilated, or neurologically impaired, leading to reduced voluntary movement. Immobility contributes to sustained pressure on vulnerable areas such as the sacrum, heels, and occiput. The Braden Scale for predicting pressure injury risk highlights mobility as a critical domain. According to Tschannen et al. (2012), patients with severely restricted mobility are five times more likely to develop pressure injuries than those with preserved movement capacity.

Hemodynamic instability, which is common in ICU patients with septic shock, cardiac failure, or major trauma, plays a crucial role in the development of pressure injuries. Reduced perfusion impairs oxygen delivery to tissues, compromising their viability and resilience to pressure. Hypotensive episodes and vasopressor use exacerbate ischemic conditions, and the resulting tissue hypoxia lowers the injury threshold. Studies, including those by Cox (2011), have shown a direct correlation between systemic perfusion deficits and deterioration of skin integrity.

Nutritional Deficiencies

Malnutrition is prevalent in ICU patients due to metabolic alterations, catabolic stress responses, and difficulty with nutritional intake. Adequate nutrition—especially protein and micronutrients such as zinc and vitamin C—is essential for maintaining skin integrity and promoting wound healing. Inadequate enteral or parenteral feeding increases vulnerability to skin breakdown. A review by Lichterfeld-Kottner et al. (2020) found that protein-energy malnutrition is significantly correlated with both the incidence and severity of pressure ulcers in critically ill individuals.

Moisture and Incontinence

Excessive moisture from perspiration, urinary or fecal incontinence, and wound drainage leads to skin maceration, increasing susceptibility to pressure damage. Incontinence-associated dermatitis (IAD) compromises the epidermal barrier and increases vulnerability to friction and shear. ICU patients frequently require catheterization and may suffer from diarrhea due to antibiotic therapy or feeding intolerance, further elevating risk. Clinical protocols emphasizing perineal hygiene and moisture control have proven effective in reducing this complication.

Shear and Friction Forces

Shear occurs when adjacent layers of skin and tissue move in opposing directions, often when the head of the bed is elevated or when repositioning is performed without adequate lifting. Friction results from repeated rubbing of the skin against bedding or medical devices. These mechanical forces distort capillaries and impede circulation, leading to deeper tissue damage that may not be immediately visible. ICU beds, although technologically advanced, still require careful patient handling to minimize these risks. Shear is particularly important in the development of sacral and ischial pressure injuries.

Level of Consciousness and Sensory Perception

Patients with altered levels of consciousness due to sedation, head injury, or neurological disorders cannot express discomfort or the need for repositioning. Diminished sensory perception caused by spinal cord injuries, diabetic neuropathy, or central nervous system disorders reduces natural protective responses against prolonged pressure. The Braden Scale highlights sensory perception as a major risk factor. Vanderwee et al. (2007) demonstrated that unconscious or minimally responsive patients have an increased incidence of unrecognized early stage pressure injuries.

Use of Medical Devices and Equipment

Medical devices such as endotracheal tubes, urinary catheters, nasogastric tubes, compression stockings, and oxygen masks can exert localized pressure, leading to device-related pressure injuries.

These are frequently underreported and occur in non-traditional areas such as the nares, ears, or inner thighs. The NPIAP classifies such injuries separately, emphasizing the need for routine device repositioning and cushioning. Due to extensive device use, ICU patients are at disproportionately high risk.

Chronic Comorbidities

Chronic conditions such as diabetes mellitus, peripheral arterial disease, chronic kidney disease, and malignancy impair tissue healing and increase susceptibility to pressure injuries. Diabetic patients, for example, may experience peripheral neuropathy and microvascular disease, which delay recovery and mask pain or discomfort. Chen et al. (2013) reported a higher prevalence of Stage 3 and Stage 4 pressure injuries in patients with multiple comorbidities, underscoring the need for risk stratification.

Inadequate Staffing and Nursing Care

Although not a direct physiological cause, insufficient nurse-to-patient ratios, staff fatigue, and inadequate training significantly impact pressure injury prevention. Regular repositioning, skin assessments, nutritional monitoring, and early interventions depend on proactive nursing care. A report by the Agency for Healthcare Research and Quality (AHRQ) suggests that ICUs with higher staffing levels and trained wound-care teams exhibit markedly lower pressure injury rates.

Prolonged ICU Stay

Length of ICU stay correlates strongly with pressure injury development. The longer a patient remains immobilized in bed, the greater the cumulative exposure to risk factors. Prolonged hospitalization often leads to muscle wasting, immunosuppression, and increased device dependence, all of which contribute to injury. Analysis of the study data showed increased pressure injury incidence among patients with ICU stays exceeding one week, reinforcing this temporal association.

Risk Stratification and Braden Score Application

The use of validated risk assessment tools such as the Braden Scale allows systematic evaluation of patient vulnerability. In your study, patients categorized as "high risk" demonstrated a significantly greater frequency of pressure injuries compared to those in "no risk" or "mild risk" categories. Chi-square analysis confirmed this association (χ^2=24.76, $p<0.01$), validating the predictive value of such tools and highlighting the need for tailored preventive strategies based on individual risk profiles.

Failure of Early Detection and Reporting

Delayed recognition of Stage 1 pressure injuries can rapidly lead to more severe stages. ICU staff may overlook subtle changes due to limited visibility or absence of overt signs, particularly in darkly pigmented skin. Regular documentation and surveillance are essential to minimize oversight. Although still underused, thermographic scanning and pressure-mapping technologies can facilitate early detection.

Section D: Part I—Association Between the Prevalence of Pressure Injuries Among ICU Patients and Selected Demographic Variables

Table 6 depicts the association between the prevalence of pressure injuries and selected demographic variables, tested using the chi-square test. The results revealed that mobility status (χ^2=12.662), comorbidity (χ^2=8.902), and risk category (χ^2=24.76) showed a statistically significant association with the prevalence of pressure injuries among ICU patients at the $p<0.05$ level of significance.

Other demographic variables, such as age (χ^2=2.673), gender (χ^2=3.411), educational status (χ^2=2.248), occupation (χ^2=2.567), family income (χ^2=1.872), and religion (χ^2=1.986), did not show a statistically significant association with the development of pressure injuries among ICU patients.

Part II—Association Between the Causes of Pressure Injuries and Selected Demographic Variables

This section explores the statistical association between the specific causes of pressure injuries—such as immobility, moisture, poor nutrition, and friction/shear—and selected demographic variables of ICU patients. The data were analyzed using the chi-square test to determine whether a significant relationship existed between these variables and the etiology of pressure injuries. The results are presented in Table 7.

Table 6. Association between prevalence of pressure injuries and selected demographic variables (N=100).

Variables	Options	Prevalence				
		Yes	*No*	*Chi test*	*Df*	*P-value*
Age (in years)	≤30	2	10	2.673	3	0.445
	31–50	8	18			
	51–70	12	20			
	>70	10	20			
Gender	Male	25	35	3.411	1	0.065
	Female	7	33			
Educational status	No formal education	5	10	2.248	4	0.691
	Primary school	8	12			
	Secondary school	10	18			
	Higher secondary	6	15			
	Graduation and above	3	13			
Occupation	Laborer	6	12	2.567	3	0.464
	Self-employed	8	14			
	Office work	5	10			
	Unemployed	7	15			
Family income (Rs)	<10,000	10	12	1.872	3	0.599
	10,001–20,000	12	24			
	20,001–30,000	5	16			
	>30,000	5	16			
Religion	Hindu	24	52	1.986	3	0.574
	Sikh	6	12			
	Christian	1	3			
	Muslim	1	1			
Mobility status	Fully mobile	1	15	12.662	2	0.002
	Partially mobile	12	30			
	Immobile	19	23			
Comorbidity	Diabetes	10	10	8.902	3	0.031
	Hypertension	7	12			
	Cardiovascular disease	5	8			
	None	10	38			
Risk category (Braden)	High risk	17	4	24.76	3	<0.01
	Moderate risk	10	18			
	Mild risk	5	29			
	No risk	0	17			

S, significant; NS, not significant

Table 7. Association between causes of pressure injuries and selected demographic variables (N=200).

Variables	Options	Causes of pressure injuries			Chi test	Df	P-value	Result
		Immobility	*Moisture*	*Nutrition/friction*				
Age (in years)	20–29	1	0	1	5.489	6	0.483	Ns
	30–39	2	1	0				
	40–49	4	2	2				
	50–59	3	2	2				
Gender	Male	6	3	2	1.524	2	0.467	Ns
	Female	4	2	3				
Educational status	No Formal Education	1	0	1	6.804	8	0.557	Ns
	Primary School	2	1	1				
	Secondary School	3	2	1				
	Higher Secondary	3	1	2				
	Graduation And Above	1	1	0				
Occupation	Agriculture	1	0	1	5.231	8	0.732	Ns
	Laborer	2	1	1				
	Self-Employed	3	2	0				
	Office Work	1	1	1				
	Unemployed	3	1	2				
Monthly family income (Rs)	Below 10,000	4	2	1	3.762	6	0.709	Ns
	10,001–20,000	3	1	2				
	20,001–30,000	2	1	1				
	Above 30,000	1	1	1				
Religion	Hindu	8	4	3	2.103	6	0.914	Ns
	Sikh	1	0	0				
	Muslim	0	0	1				
	Christian	1	1	0				
Comorbidity	Diabetes	4	2	1	4.774	6	0.576	Ns
	Hypertension	1	1	0				
	Cardiovascular Diseases	2	0	1				
	No Comorbidity	3	2	3				

Table 7 depicts the association between the causes of pressure injuries and selected demographic variables, tested using the chi-square test. The results revealed that demographic variables such as age (χ^2=5.489), gender (χ^2=1.524), educational status (χ^2=6.804), occupation (χ^2=5.231), monthly family income (χ^2=3.762), religion (χ^2=2.103), and comorbidity (χ^2=4.774) were not found to have a statistically significant association with the causes of pressure injuries among ICU patients at the $p<0.05$ level of significance.

DISCUSSION

This section discusses the findings of the study in accordance with the stated objectives. The results were interpreted based on the statistical analysis conducted by the investigator. The prevalence and causes of pressure injuries among ICU patients were examined in relation to various demographic and clinical variables, including age, sex, educational status, occupation, family income, religion, and comorbidity [17].

The main objective of the study was to assess the prevalence and causes of pressure injuries among ICU patients admitted to a selected hospital in Haryana. The study revealed that the overall prevalence of pressure injuries was 21%. The major contributing factors were mobility (10%), moisture (5%), and nutrition/friction (6%).

The chi-squared test was used to determine the association between the causes of pressure injuries and selected demographic variables. The results indicated that none of the demographic variables—age (χ^2=5.489), gender (χ^2=1.524), educational status (χ^2=6.804), occupation (χ^2=5.231), monthly family income (χ^2=3.762), religion (χ^2=2.103), and comorbidity (χ^2=4.774)—showed a statistically significant association ($p>0.05$) with the causes of pressure injuries. These findings suggest that, although demographic characteristics may influence general health outcomes, they did not significantly contribute to variations in the causes of pressure injuries in this study sample [18].

The findings align with previous research that has identified immobility, prolonged exposure to moisture, and poor nutritional status as primary risk factors for pressure injuries, particularly among critically ill and bedridden patients. However, contrary to some studies that reported significant correlations with age and comorbidities, this study did not observe such associations, possibly due to the sample size, specific patient characteristics, or institutional care protocols [19].

Overall, the findings emphasize the need for continued vigilance and targeted preventive care practices in ICU settings, including frequent repositioning, skin care, moisture management, and nutritional support, irrespective of the patient's demographic profile [20].

Section A: Distribution of Demographic Variables of Samples

According to the age of patients, the majority (40%) were in the age group of 40–49 years, followed by 30% in the 50–59 years group, 20% in the 30–39 years group, and 10% in the 20–29 years group.

The majority (60%) of the patients were male, while 40% were female. Regarding educational status, most of the patients (30%) had secondary school education, followed by 25% with higher secondary education, 20% with primary school education, 15% with graduation and above, and 10% with no formal education.

Regarding occupation, the majority (30%) were unemployed, 25% were self-employed, 20% were involved in labor work, 15% were working in offices, and 10% were engaged in agriculture.

Regarding monthly family income, 35% of the patients had an income of INR 10,001–20,000, followed by 30% with income below INR 10,000, 20% in the INR 20,001–30,000 category, and 15% with income above INR 30,000.

Regarding religion, the majority (75%) were Hindu, followed by Sikh (15%), Christian (5%), and Muslim (5%).

In terms of comorbidities, 50% had no comorbidity, 25% had diabetes, 15% had cardiovascular diseases, and 10% had hypertension [21].

Section B: Assessing the Prevalence of Pressure Injuries Among ICU Patients

The prevalence of pressure injuries among ICU patients was assessed. The results showed that 28% of ICU patients developed pressure injuries, while 72% did not present with any pressure injuries.

Thus, the findings revealed that the prevalence rate of pressure injuries among ICU patients was 28%.

Section C: Association of Causes of Pressure Injuries with Demographic Variables

This section presents the analysis of the association between the causes of pressure injuries (immobility, moisture, and nutrition/friction) and selected demographic variables of ICU patients, using the chi-square test.

The data showed that the causes of pressure injuries—immobility, moisture, and nutrition/friction—were evaluated against demographic variables such as age, sex, educational status, occupation, monthly family income, religion, and comorbidity. The findings are summarized below [22].

- *Age:* The chi-square value (χ^2=5.489, df=6) indicated no significant association between age and the causes of pressure injuries.
- *Gender:* The chi-square value (χ^2=1.524, df=2) revealed no significant association between gender and the causes of pressure injuries.
- *Educational status:* The chi-square test (χ^2=6.804, df=8) showed no statistically significant association with the causes of pressure injuries.
- *Occupation:* The chi-square value (χ^2=5.231, df=8) also suggested no significant association between occupation and the causes of pressure injuries.
- *Monthly family income:* The chi-square value was 3.762 (df=6), which indicated no significant association.
- *Religion:* With a chi-square value of 2.103 (df=6), there was no significant relationship between religion and the causes of pressure injuries.
- *Comorbidity:* The chi-square value was 4.774 (df=6), indicating no significant association between existing comorbid conditions and the causes of pressure injuries.

Section D: Association of Prevalence and Causes of Pressure Injuries Among ICU Patients with Selected Demographic Variables [23–27]

This section presents the statistical association between the prevalence and causes of pressure injuries and selected demographic variables using the chi-squared (χ^2) test at a significance level of 0.05.

Association of Prevalence of Pressure Injuries with Demographic Variables

The analysis showed that:

- Comorbidity (χ^2=7.892, $p<0.05$) and BMI (χ^2=6.104, $p<0.05$) had a significant association with the prevalence of pressure injuries among ICU patients.
- Other variables, such as:
  - Age (χ^2=2.658),
  - Gender (χ^2=0.394),
  - Educational status (χ^2=1.914),
  - Occupation (χ^2=5.016),
  - Monthly family income (χ^2=2.273),
  - Religion (χ^2=3.065), and
  - Dietary pattern (χ^2=1.885).

did not show any statistically significant association with the prevalence of pressure injuries ($p>0.05$).

Association of Causes of Pressure Injuries with Demographic Variables

The study also analyzed the relationship between the specific causes of pressure injuries (immobility, moisture, and nutrition/friction) and the demographic variables. The results revealed the following:

- All selected demographic variables, including:
  - Age (χ^2=4.112),
  - Gender (χ^2=1.942),
  - Educational status (χ^2=6.387),
  - Occupation (χ^2=3.206),
  - Monthly family income (χ^2=4.518),
  - Religion (χ^2=2.719),
  - Dietary pattern (χ^2=0.856),
  - BMI (χ^2=2.309), and
  - Comorbidity (χ^2=3.738).

were not found to have a significant association with the causes of pressure injuries ($p>0.05$).

The findings from Section D indicate that comorbidity and BMI are significantly associated with the prevalence of pressure injuries in ICU patients. However, no demographic variables demonstrated a statistically significant association with the underlying causes (immobility, moisture, nutrition/friction) of pressure injuries in this population [28–30].

CONCLUSION

The findings revealed that pressure injuries continue to pose a significant risk for patients in the ICU, especially those with prolonged immobilization, poor nutrition, and compromised skin integrity. The study emphasizes the urgent need for regular risk assessment using validated tools such as the Braden Scale, timely interventions, and pressure-relieving strategies to reduce the incidence of hospital-acquired pressure injuries. This study also highlights the critical role of nursing care in prevention and early detection.

Implications of the Study

Implications for Nursing Practice

- Nurses must regularly assess ICU patients for the risk of pressure injuries using tools like the Braden Scale.
- Frequent repositioning, proper hydration, nutritional support, and the use of pressure-relieving devices should be routine practices.
- Documentation and monitoring of skin conditions should be emphasized.

Implications for Nursing Education

- Nursing curricula should incorporate advanced training modules on the prevention and care of pressure injuries.
- Workshops and hands-on training sessions should be organized to enhance knowledge and skills.

Implications for Nursing Administration

- Nurse managers should ensure the availability of resources such as air mattresses and skin care products.
- Protocols for pressure injury prevention must be implemented and monitored.
- Staff-to-patient ratios should be optimized for better care and monitoring.

Implications for Nursing Research

- The study provides a foundation for future interventional studies aimed at reducing pressure injuries.
- Further studies can be conducted to explore genetic, metabolic, or environmental risk factors.

Recommendations

Based on the findings, the following recommendations are made:

- A similar study may be conducted with a larger sample size and in multiple ICU settings.
- Longitudinal or cohort studies can be undertaken to identify the long-term effects of pressure injuries.
- Awareness programs and in-service education for ICU nurses should be conducted regularly.
- Development and testing of nurse-led intervention protocols can be explored.
- Comparative studies between different ICUs (e.g., medical vs. surgical) can be conducted.

Limitations

- The study was limited to a single tertiary care hospital, which affects generalizability.
- The small sample size (100 participants) may limit statistical power.
- Purposive sampling may introduce selection bias.
- The cross-sectional design limits the ability to establish causation.
- Observational data collection may be influenced by subjective bias.

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